Fish make noise

Information on the FishBase **Fish Quiz** at SLOW FISH Genova 2019

Background

Contrary to the perception of most people, the sea is by no means a quiet oasis. In addition to the relatively high level of abiotic background noise (e.g., air turbulence from propellers, waves, etc.), invertebrates, fish, and marine mammals produce a wide range of acoustic signals of various frequency and volume.

Even in ancient Greek and Roman sources, there is evidence that it was known that fish and marine mammals make noises. Thanks to improved technical aids such as hydrophones, it was demonstrated in the 20th century that more than 80 fish families produce noises.

Many fish species have fairly advanced hearing, especially in the lower frequency ranges. There is a moderate, but significant concurrence of vocalization bandwidth and hearing bandwidth for species for which data are available on both, hearing abilities and sound production. This indicates that the improvement of hearing and refinement of vocalisations may have co-evolved in the context of intraspecific communication. However, some fish, such as the cod (*Gadus morhua*), are also able to hear ultrasound outside their own vocalization. It is speculated that they have developed this ability to avoid their communicating predators such as toothed whales.

Humans across different cultures have exploited sonic abilities of fish for centuries, often to this present day. Localizing fish by listening to species-specific acoustic signals is an art form that has been employed in fisheries. Alternatively, man-made low frequency sounds or noises have been employed as a means to either lure or scare fish into being caught in a variety of gear types, such as gill and seine nets as well as hook and line.

Fish sounds

Fish may generate acoustic signals either passively or actively. The **passive** type of signals – also referred to as 'mechanical' sounds – are generated as by-products of foraging, moving or other activities. The **active** – or 'biological' - sound production involves the use of organs, which, though initially evolved to perform other functions, are also especially adapted to generate acoustic signals. Both can have biological meaning. The puffer (*Spheroides maculatus*) may be attracted to a feeding site by the – passively produced - chewing sounds of other members of its species, while

 Puffer	 Squirrel fish	 Cod	 Grunt

squirrel fish (*Holocentrus ascensionis*) and other species are known to actively generate sounds during competitive feeding interactions.

The **swim bladder** is the most commonly used **sound production organ** in fish for active vocalizations. This membranous air-filled sac fulfills several other functions, most importantly regulating the animals' buoyancy in the water, in addition to playing a role in the auditory system of fish. In the context of sound production, the swim bladder can either function as the actual sound generator itself or as an amplifier for sounds generated by other body parts including e.g. the pectoral girdle, fin rays, various other bones or the incisors. Most commonly, however, sounds amplified in such a way are generated by **pharyngeal teeth** (patches of mosaic-like denticles located far back in the pharynx) which most fish species possess.

When **passive noise** is a by-product of other activities, the involved body parts, such as teeth (feeding sounds) or the entire body or the tail (swimming or hydrodynamic sounds) could be regarded as the 'sound production organ'.

The **sonic mechanism** is the actual underlying physical mechanism that generates the sound. Fish actively produce sounds using different mechanisms. A predominant one is the vibration of the air-filled **swim bladder** through sudden contraction of the skeletal musculature, with e.g. rapid acceleration, evasive movement or a startle reaction. The resulting 'escape sounds' are a type of acoustic signal which the majority of fish with swim bladders seem to be able to produce.

Alternatively, swim bladder vibrations may be initiated by means of specialized muscles sometimes working in conjunction with modified bones. These muscles may be embedded directly in the wall of the swim bladder ('intrinsic musculature' e.g. mulletes - Triglidae) or may exist in the form of 'drumming' muscles extrinsically associated with the swim bladder (e.g. Sciaenidae). Furthermore, externally induced vibration of the swim bladder in some species may be achieved by means of rhythmic beating of finrays against the body surface (e.g. *Balistes carolinensis*). The type of sound actually generated by the vibrating swim bladder is mainly determined by the size and the shape of the swim bladder.

Generally, however, **these sounds are low-pitched, guttural** and drum-like (i.e. 'grunts', 'groans', 'thumps', 'knocks', 'clucks', 'booms' or 'barks') with fundamental frequencies ranging between 25 – 250 Hz and an upper frequency of 800 Hz and are quite loud. In contrast, sounds associated with the release of gas bubbles from the swim bladder, such as sometimes produced by Physostomi fish species, which have maintained a **pneumatic duct**, are generally relatively faint.

The pneumatic duct is the connection of the swim bladder with the pharynx or mouth and is not preserved in all adult fish with a swim bladder.

Relatively loud, higher pitched 'rasping' or 'scratching' sounds are produced by the **grinding of incisors** or – more commonly - the **stridulation of pharyngeal teeth**. In some species (e.g. grunts, Haemulidae) these stridulatory sounds may be amplified considerably by a resonating swim bladder located in close proximity to the pharyngeal teeth.

Other types of sonic mechanisms include the stridulation of different body parts against each other (e.g. some sea horses, Syngnathidae) or the spasmodic contraction of heavy skeletal muscles resulting in a low-pitched droning, like the hum of an electric motor (e.g. Cottidae).

All about fish: www.fishbase.de, www.fishbase.org, www.fishbase.ca, www.fishbase.se